U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 124.

Experiment Station Work,

XVII.

DISTILLED DRINKING WATER.
SOIL INOCULATION.
TREATMENT OF SANDY SOILS.
LIME AS A FERTILIZER.
FERTILIZERS FOR MARKET-GARDEN CROPS.
PECAN CULTURE.
WEED DESTRUCTION.
MAPLE SIRUP AND SUGAR.
VALUE OF COTTON SEED.
ALFALFA SILAGE.
FORAGE CROPS FOR PIGS.
GRAZING STEERS.
TYPE OF THE DAIRY COW.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

CONTENTS OF THE SERIES OF FARMERS' BULLETINS ON EXPERIMENT STATION WORK.

EXPERIMENT STATION WORK.

Editor: W. H. BEAL.

CONTENTS OF NO. XVII.

ILLUSTRATIONS.

EXPERIMENT STATION WORK—XVII.[1]

DISTILLED WATER FOR DRINKING PURPOSES.

Impure water is undoubtedly the cause of much sickness and ill health, and this is as true of the country as of the towns. The impurity of the water supply is often the result of carelessness or indifference, but in many cases, as, for instance, in regions where the soil is impregnated with alkali, it is unavoidable. Distillation affords an effective means of obtaining water free from disease germs and objectionable mineral matter.

Professor Bolley states in a recent report of the North Dakota Station:

> It is now generally agreed among physicians that the use of distilled water for drinking purposes would save from much disease and ill health.
>
> There is no cheap distilling apparatus on the market suited to use upon the kitchen stove, none which can produce sufficient distilled water for the use of a family. I have therefore undertaken to plan a distilling apparatus which any tinsmith can construct at small cost, and one which will provide a large amount of distilled water.
>
> The following described apparatus can be constructed at a cost of $5 to $10. Upon the ordinary kitchen stove it will furnish from 7 to 20 gallons of water per week, according to the constancy of the fire. One has been in use in my home one year and three months, and has furnished a constant supply of pure water.

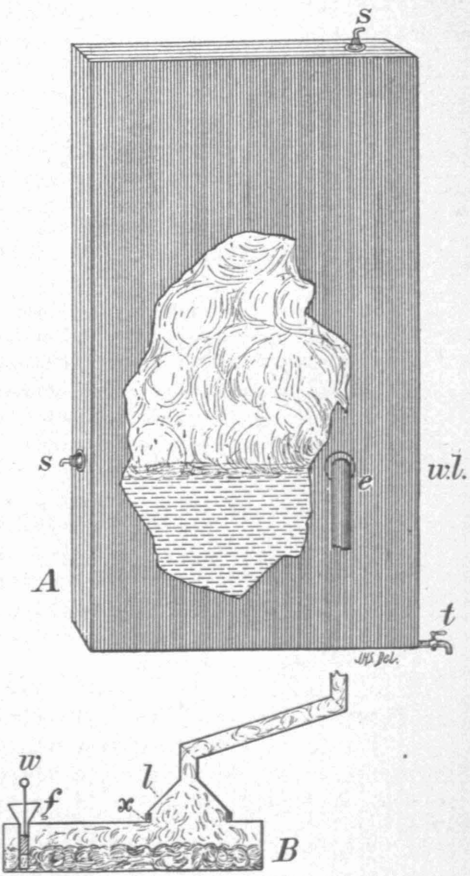

FIG. 1.—Simple apparatus for preparing distilled water.

---

[1] This is the seventeenth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred insti-

Directions for construction.—The parts to be constructed are shown in fig. 1, the condenser *A* and the evaporator *B*. Make an inclosed evaporator pan, *B*, large enough to cover two holes of a kitchen stove or range, say 21½ inches by 9¾ inches by 4 inches, for a No. 9 stove. It is inclosed at all points except only the filling funnel (*f*) and the steam-escape tube (*l*). The funnel tube is three-fourths inch in diameter, is soldered into the top of the pan, and reaches within one-eighth of an inch of the bottom to prevent escape of steam. The steam tube (*l*) is made in the form of a lid 7 inches wide and fits closely into a double rim (*x*), which prevents the escape of the steam and allows return drippings from the tube to run back into the evaporator through a small perforation. At *w* is a wire loop attached to a cork float showing the water content of the evaporator. If lid (*l*) is placed in the pan the same distance from the end as from the sides it will be possible to turn the evaporator either across or lengthwise of the stove. The evaporator may be made either of galvanized iron or tinned copper. The flat nature of this pan furnishes a good warming shelf or rest, hence is not a waste of space when upon the stove. Tube (*l*) of the pan should be 1½ inches in diameter and so made as to slide into tube (*e*) of the condenser. *A* is a surface, air condenser, and water reservoir. It rests upon small brackets upon the wall back of the stove and above the level of the evaporator.

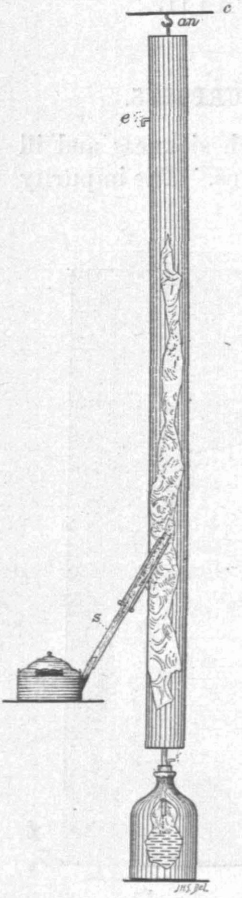

FIG. 2.—Form of distilling apparatus for household use.

Make the condenser (*A*) of bright tin into the form of a tight flat box, 3 inches deep, 4 feet long, and 27½ inches wide. Stock tin usually comes in sheets 20 inches by 28 inches. It can be made longer than 4 feet to advantage if there is sufficient wall space; *e* is the tube through which steam enters; *t* is a faucet for drawing off the water; *wl* shows water line, about 5 gallons, the condenser will hold at one time; *S* shows two small steam escapes made by fitting tin screw caps over one-fourth inch openings into the condenser. The screw caps are perforated by one-fourth inch holes in which are small bent tubes. These may be so turned as to direct escaping steam away from the wall and prevent the entrance of dust into the condenser.

Fig. 2 shows a very effective condenser. It consists of a tin cylinder 7 feet long and 4½ inches in diameter, having a sliding connection (*S*) for catching the steam from an ordinary teakettle. This tube slides into a fixed tube so there is no return drop water. This simple still should be made of bright tin, and costs something less than $2 to make. At *e* is a small elbow steam escape. The condenser is constructed to hang from a hook (*c*) in the ceiling by a string or wire connection (*an*). When kept in constant operation this still will easily furnish 1 to 3 gallons of water

---

tutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can

per day. If the kitchen ceiling is sufficiently high the cylinder may be made longer to advantage. As it swings behind the stove or range out of the way when not in use, this is a very convenient form of condenser. In making these condensers all seams should be soldered on the outside to prevent the contact of the solder with the drinking water.

—THE EDITOR.

SOIL INOCULATION FOR LEGUMINOUS PLANTS.

Of the three elements going to make up the value of fertilizers, nitrogen is by far the most expensive. While this element is abundant in nature, forming four-fifths of the atmosphere, it is only under certain rare conditions that this uncombined nitrogen becomes available for plant growth. It has long been known that leguminous plants, such as clover, alfalfa, and cowpeas are unusually rich in nitrogen, and increase the nitrogen content of the soils on which they grow. This was not explained until science brought out the fact that this family of plants is able to obtain nitrogen from the air. It has been found that the power of securing free nitrogen exists only when small nodules or tubercles containing bacteria are found on the roots. It is now generally believed that these bacteria draw their nitrogen from the air and convert it into forms which can be utilized by the plants on which the nodules grow.[1]

In growing these renovating crops for improving the soil it is important to know whether the nodules are formed upon the roots. If they are not there, the greater benefit from growing such crops is lost and the soil makes no actual gain in nitrogen. Where a crop like clover has been grown at intervals for a series of years, it is probable that the soil will contain the proper bacteria for forming tubercles. It has been found, however, that the bacteria growing upon the roots of one legume, as clover, may not grow upon the roots of another genus, as the cowpea. Therefore, where the nodules are not formed, as is very probable with leguminous plants new to the section where planted, it is advisable in seeding the plants to also sow their proper inoculating bacteria. The absence of root tubercles will probably account for the reported failures of leguminous crops in many sections.

A recent report states that the soy bean has been grown at the Kansas Station since 1890. Only recently, however, have tubercles formed upon the roots, and this was brought about by artificial means. Inoculated soil was obtained from a soy bean field at the Massachusetts

---

show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Station.

[1] See also U. S. Dept. Agr., Farmers' Bul. 65 (Experiment Station Work—II), p. 19.

Station, and by scattering it over the Kansas land, plants with tubercles were grown, producing an increased yield and a higher percentage of nitrogen. Several methods of inoculating were tried. The seeds were thoroughly wetted in a bag suspended in water, into which the Massachusetts soil had been stirred. Again, the dry soil was sown broadcast over the fields, and in other cases was drilled with the seed. The best results were obtained by sowing inoculated soil in the drills. The method of securing inoculated soil and of inoculating a field is described as follows: In a 500-foot row incorporate 100 pounds of inoculated soil with the seed at the time of sowing. After harvesting the crop take up the soil in the row to a depth of 4 to 5 inches, spread on boards in the shade until dry, and sack. When planting a field to soy beans apply this soil with the seed by means of a fertilizer attachment to the grain drill.

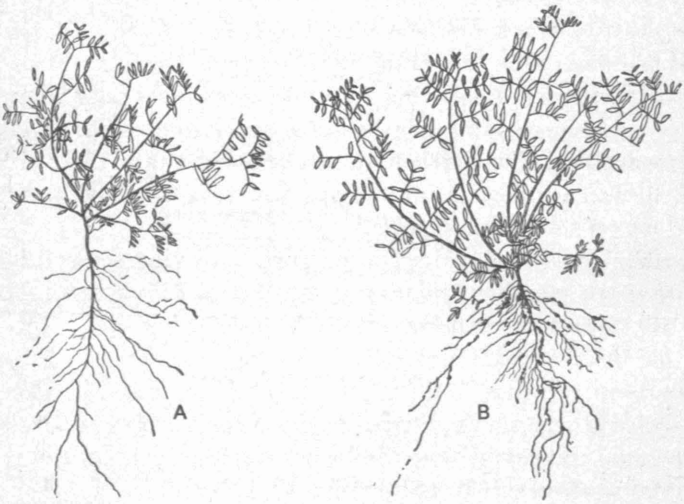

FIG. 3.—Hairy vetch plants grown on uninoculated and inoculated plats: A, uninoculated; B, inoculated, showing root nodules.

The Alabama Station has experimented with commercial inoculating material (Nitragin) and inoculated soil on a variety of crops, but especially with hairy vetch and crimson clover as winter-cover crops. It was found that while vetch and clover during the first year developed only a few tubercles on the station soil and made poor growth or failed entirely, they were after a few years of continuous growth abundantly supplied with them and made good growth. However, it would seem hardly profitable to wait for the slow action of natural inoculation when the desired result can be easily and quickly accomplished by artificial means. Where there is a small patch of clover, vetch, or peas, bearing root nodules, a field of a similar crop may be readily inoculated by using soil from the former. At the Alabama Station the crops were inoculated by applying soil from old fields

and by dipping the seed previous to sowing in water into which had been stirred soil from an old garden. Artificial cultures (Nitragin) were also used, but their cost, together with liability to deteriorate, are believed to preclude their use in general farm practice.

In the experiments with hairy vetch grown on a soil for the first time, one lot of seed was dipped into a water solution of earth from an old garden spot where vetch had grown, and another was sown without treatment. The inoculated plants had large clusters of tubercles on the roots and produced 2,540 pounds of cured hay per acre. The uninoculated plants had no tubercles on the roots and produced 232 pounds per acre (fig. 3). The soil of the inoculated plat, besides producing the larger crop, was left in much better mechanical condition. In a crop of crimson clover, seed inoculated with Nitragin produced an average of 4,057 pounds; not inoculated, 761 pounds per acre (fig. 4). Not only was the total amount of forage increased in the above instances, but there was a larger percentage of nitrogen in the inoculated plants. The total amounts of nitrogen contained per acre in the crops were as follows: Hairy vetch—inoculated, 105.5 pounds; not inoculated, 7 pounds. Crimson clover—inoculated, 143.7 pounds; not inoculated, 4.3 pounds.

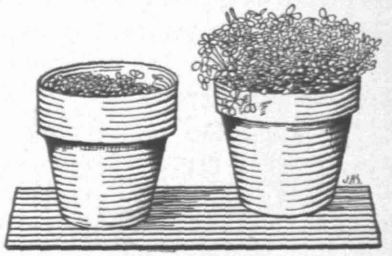
A B

FIG. 4.—Crimson clover growing on uninoculated and inoculated soil in pots: A, uninoculated; B, inoculated.

In earlier experiments at this station the average increase in weight of the inoculated plants, after thorough drying, was with hairy vetch, 89 per cent; Canada field peas, 138 per cent; crimson clover (young plants), 146 per cent. In a soil which had not borne leguminous plants for many years, some tubercles developed on hairy vetch, Canada field peas, crimson clover, lupines, cowpeas, and Japan clover (*Lespedeza striata*). Yet, even on this soil the increase in weight of plants by inoculation was with hairy vetch 38 per cent; Canada field peas, 58 per cent; and crimson clover, 79 per cent.

In experiments with hairy vetch at the Mississippi Station the yield was increased 64.6 per cent by scattering inoculated soil in the drills with the seed, and 34 per cent by soaking the seed in water containing the tubercle germs. The amount of nitrogen was also considerably increased by inoculation. The inoculated soil used was obtained from a field bearing hairy vetch which had an abundance of nodules. As regards methods of inoculation, the Mississippi Station makes the following statements:

> There are at least three methods of inoculating soil with these germs. One method is to find a field on which a crop of vetch, peas, or clover has grown, on the roots of

which an abundance of nodules was developed. In such a case one may be sure that the soil of the old vetch or clover field is full of germs that escaped from the nodules when they decayed. Then draw dirt from this field, about 1 ton to the acre, and scatter as evenly as possible over the one to be inoculated. It should then be quickly harrowed in, especially if it is a hot, clear day, because sunshine kills the germs. The dirt should be taken preferably from 2 to 3 inches below the surface. A second method is to obtain some earth from an old inoculated vetch or clover field, put it in a vessel, and pour water on it. Then stir thoroughly, allow it to settle, and use this water to thoroughly wet the seeds to be sown. The water thus obtained is full of germs from the soil, which will stick to the seeds as they dry. Here again we should use care and not dry the seeds in the sunlight. This [seems to be] the most economical way of inoculating a field. It is not a difficult matter to spread out a bushel or two of clover or vetch seed on an old cloth or tight floor, and sprinkle with plenty of the muddy germ water. The seeds may be left right there until they dry, if they are in the shade, and then are ready to sow. A third method is to buy a material known as Nitragin. This is simply a gelatinous substance full of the germs one wishes to use. It is made in Germany, and consequently in the trip across the ocean and then to us it is very liable to ferment and spoil.

Even if the Nitragin can be obtained in good condition its cost renders its use of doubtful economy, as already stated.

In using inoculated soil it should be borne in mind that while experiments have shown that the germs from one plant will inoculate very closely related plants and even in some cases those distantly related, the best results will probably be obtained by using germs from the same species of plant as that which it is proposed to inoculate.

It is important to bear in mind that soil inoculation for leguminous plants is most valuable for poor soils deficient in nitrogen, and is not likely to prove profitable on soils abundantly supplied with available nitrogen. In experiments at the North Dakota Station with peas and red clover grown on pure sand and on a garden soil rich in nitrogen it was found that inoculation with Nitragin resulted in a largely increased yield in case of the sand, but produced little increase on the garden soil.—D. W. MAY and THE EDITOR.

TREATMENT OF SANDY SOILS.

A recent bulletin of the Rhode Island Station makes practical suggestions regarding the management of sandy soils, especially as applied to what is known as the Warwick plain in the vicinity of Providence. The soil of this plain is described as a light sandy loam in "great need of most, if not all, of the kinds of plant food which are liable to be lacking in soils." Like many other soils of this character, however, when properly managed it is peculiarly suited to market gardening and produces early vegetables of fine quality. One of the first requirements of such soils is an increase of humus to improve the water-holding capacity, and thus to mitigate the disastrous effects of drought. This can be very effectively accomplished by the growth of crops to be turned under as green manure. For this purpose the leguminous

plants which collect nitrogen from the air especially commend themselves (see p. 7). Such plants especially recommended for the Rhode Island soils are lupines of different kinds, serradella (with spring grain), cowpeas, soy beans, crimson clover, Canada field peas (with oats), and vetch (with oats). This list can doubtless be varied for other localities with advantage.

Buckwheat and rye, two crops often used in green manuring, are too familiar to all to require notice other than to say that they, unlike the plants that have been mentioned, are supposed to be unable to make the same use of atmospheric nitrogen.

Though recognizing the general principle that if a crop is one that can be fed to stock it is usually better economy to utilize its food value and apply the resulting manure to the land than to plow the crop under, there are perhaps instances, particularly in the case of sandy soils which are used for truck farming, where the plowing in of green crops may be practiced with much immediate profit and with great ultimate benefit to the soil.

Other things being equal, the thoughtful farmer will grow, for the renovation of his soil, crops which can utilize atmospheric nitrogen, since what is thus obtained would cost at present from 13½ to 17 cents per pound, if purchased at retail in the form of common fertilizers.

Moderate liming improves both the physical and the chemical properties of sandy soils.

Wood ashes, leached or unleached, may be safely used to furnish lime. Where but little potash is needed, leached ashes would give practically as good results as unleached ones. Freshly slaked lime is not so safe for such soils as that which has been exposed to the air for a longer time. Large single applications of lime should not be made to sandy soils. One ton per acre may usually be considered a maximum application. Lime composted with muck or other organic matter is brought into excellent condition to apply to soils of this character. * * *

There is no form of nitrogen which acts so quickly as nitrate of soda. Upon sandy soils it must, however, be used cautiously. The soil is so open and leaching takes place so readily that it should be applied periodically, and only in such quantities as would seem to be needed in the near future. * * *

Sulphate of ammonia would be less liable to leach than nitrate of soda, though upon acid soil it has been found to exert an injurious action, either immediately or in the course of a few years, provided the soil is not treated with lime, wood ashes, or considerable quantities of stable manure. If sandy soil is heavily limed, there is danger that the ammonia in sulphate of ammonia may be driven out of the soil in the form of gas and thus wasted.

Where it is not convenient to make frequent applications, and where the growth of the crop covers a long period of time, nitrogen in organic matter is probably the safest to apply upon sandy soils. The best grades of dried blood, containing from 12 to 13 per cent of nitrogen, furnish this substance in a more effective form than fish, tankage, or other materials. If prices are satisfactory, fish, tankage, and cottonseed meal may be used to good advantage. Lower grades of "blood" are liable to be adulterated.

For sandy soils sulphate of potash might have an advantage in wet seasons and muriate in dry ones. A mixture of the two would, perhaps, generally be the safest. Potash in sulphate usually costs from one-fourth to half a cent per pound more than in muriate of potash, a factor which is not without influence in their selection. * * *

[In the case of acid, or sour, and leachy soils] basic slag meal is probably the nearest to an ideal source of phosphoric acid that can be applied. This is nearly

as effective as acid phosphate, dissolved boneblack, dissolved bone, or double superphosphate, and is far less liable than the latter to loss by leaching. * * * Bone is far more effective upon sandy than upon clayey soils, * * * while floats (finely ground "undissolved" phosphate rock) might give good results. * * *

Where quick action is desired, basic slag meal or superphosphate should be employed. The choice between dissolved bone, dissolved boneblack, acid phosphate, and "double superphosphate" will be determined largely by the price of each.

—THE EDITOR.

FERTILIZING VALUE OF DIFFERENT FORMS OF LIME.

The Maryland Station reports experiments with lime extending over a number of years. Lime was used in a variety of forms: Burnt lime freshly slaked, 1,400 pounds per acre; oyster shells, 2,600 pounds; gas lime, 2,925 pounds; gypsum, 4,125 pounds, and shell marl, 13,000 pounds per acre, etc. The soil on which the experiments were made was a run-down sandy loam naturally well drained. Some of the results obtained, while not conclusive or to be taken as applying to all soils, are at least suggestive.

All the applications of lime increased the yields. * * * The best yields were obtained with the lime in the form of carbonate, the finely ground oyster shells standing first, and the shell marl standing second. This was further substantiated when the stone lime was applied as a top-dressing, and given an opportunity to form carbonate of lime by absorption of carbonic acid from the atmosphere. * * *

Magnesian lime, which is commonly claimed to be poisonous to the soil and crop, gave the highest yield. * * *

Lime applied so as to slake in the soil produced a slightly better total yield than when first slaked and harrowed in. * * *

Stone lime and shell lime were of about the same value on the soil.

Lime with fertilizer was more profitable than depending upon fertilizer alone.

The soil used in these experiments seemed to possess some unusual characteristics, so that the same results might not be obtained on other soils. It will be necessary therefore for many of the questions relating to liming to be settled for each farm. The above experiments indicate some of the points which should be tested by the farmer for himself.—THE EDITOR.

NITROGENOUS FERTILIZERS FOR MARKET-GARDEN CROPS.

When the farmer buys commercial fertilizers for his fields, the cost of growing crops is considerably increased. A direct cash investment is made, the returns from which may be much or little, depending to a great extent upon the knowledge of the buyer in the use of such fertilizers. Soil in fair condition as regards the essential elements of fertility and given over to the culture of ordinary staple crops may give profitable yields only when medium amounts of fertilizers are used, while the profit obtained from growing certain high-priced garden crops on rich soils may be greatly increased by heavy appli-

cations of the most expensive forms of fertilizers. Some of the many problems involved in the economic use of the different forms of the essential constituents of fertilizers—phosphoric acid, potash, and nitrogen—have been worked out by the experiment stations; others are still in the experimental stages. It is known that any surplus phosphoric acid or potash which may be applied to a crop will usually remain in the soil for the use of succeeding crops, while any surplus nitrogen is likely to be lost in the soil drainage water or escape into the air in the free state. The economic use of any large amounts of nitrogen in its different forms thus becomes a problem of considerable importance, especially since nitrogen is the most expensive of the three essential fertilizing elements.

A contribution to our knowledge of the profitable use of the different forms of nitrogen in the field production of early market garden crops has appeared in a bulletin from the New Jersey Experiment Station. The experiments reported were carried out on a rich truck-garden soil which annually received fertilizers far in excess of the amounts removed by the crops grown. The experiments were designed to furnish information as to the relative usefulness of nitrate, ammonia, and organic forms of nitrogen for crops "belonging to that class in which rapid and continuous growth are important factors in determining the profits to be obtained in the growth of the crop." The crops grown were table beets, tomatoes, muskmelons, sweet corn, potatoes, sweet potatoes, and certain forage crops. The experimental plats were well fertilized in each case with phosphoric acid and potash before the nitrogen was applied. The data given relative to table beets, tomatoes, muskmelons, and sweet corn is herewith summarized:

Table beets.—With this crop the relative profitableness of increasing amounts of nitrate of soda, one of the most available forms of nitrogen, was studied. The soil used was a well-drained sandy loam, which had been cropped for ten years with table beets and celery and each year had been fertilized with 20 tons of well-rotted barnyard manure and 1 ton of complete commercial fertilizer, furnishing 52.5 pounds of nitrogen, 110 pounds of available phosphoric acid, and 87.5 pounds of actual potash per acre. The nitrate of soda was applied on different plats of this soil at rates of 400, 500, 600, and 700 pounds per acre in three equal dressings.

The earliness of the crop was greatly hastened by the use of the nitrate. At the first picking the average yield of 2-pound bunches from the nitrate plats was 63 per cent greater than from the check plats. At the gathering four days later this yield was 135 per cent greater, and at the third gathering three days later 17½ per cent greater. From that time on the yields of the different plats were about equal. The different amounts of the nitrate increased the extra earliness of the beets from 10.1 per cent, in the case of the plat receiving the least

nitrate, to 23.7 per cent in the case of the plat receiving the greatest amount, though not in regular ratio. The largest prices were received for the earliest gatherings, and the greatest net gain per acre over the control plat—$27.10—was obtained from the plat fertilized at the rate of 700 pounds in nitrate of soda per acre. In this experiment, for every dollar invested in nitrate of soda nearly $3 was returned in the increased value of the crop. "The experiment strongly emphasizes the importance of the sufficiency of available nitrogen for crops of this class, as well as the profits that may be derived from such applications."

Tomatoes.—This experiment was planned to study the comparative value to the tomato crop of nitrate of soda, sulphate of ammonia, and dried blood as sources of nitrogen. The effect of the different fertilizers on the yield and quality of the crop for early market was the prime object of the test. Nitrate of soda was used at the rate of 150 pounds, sulphate of ammonia 120 pounds, and dried blood 200 pounds per acre.

The use of all forms of nitrogen resulted in a large increase of fruit.

The yield from nitrate of soda was 12 per cent greater than from sulphate of ammonia and 68 per cent greater than that from dried blood; it was, in fact, as large as could be expected from the entire use by the plant of all the nitrogen applied in this form, while in the case of the other forms the plants were unable to appropriate it rapidly enough to permit of a maximum development of fruit. * * * The net gain from the application of 150 pounds of nitrate of soda, costing $3, was $160, or a return of $53.33 for every dollar expended; from sulphate of ammonia, $132.77, or a return of $44.26 for every dollar expended; and from dried blood, $67.65, or a return of $22.55 for every dollar expended.

The influence of the different forms of nitrogen used on the development of the fruit is noted.

The nearer the plant is normally fed the larger will be the proportion of perfect fruits, and while in crops of this sort the aim is to obtain the largest amount of early crop, it is shown that the largest total crop, the largest early crop, and proportionately the fewest imperfect fruits were found on the plat upon which nitrate of soda, the immediately available form of nitrogen, was used, and that the proportion of culls increased as the rate of availability of the nitrogen applied decreased. The largest percentage of imperfect fruits on the fertilized plats was produced on the plat upon which dried blood was used.

It is not likely in actual practice that progressive farmers would attempt to grow tomatoes without an application of nitrogen in some form, but it is a fact that too many use too little and are not particular to obtain the quickly available forms. These results show not only the great importance of an abundance of nitrogen, but the very great value of the readily available forms.

Muskmelons.—The same fertilizers as were used in growing tomatoes were used in growing muskmelons, the relative value of increasing amounts of each fertilizer for this crop being tested. Beginning with 150 pounds of nitrate of soda, 120 pounds of sulphate of ammonia,

and 200 pounds of dried blood in the first series these amounts were increased $1\frac{2}{3}$ and $2\frac{1}{3}$ times in the second and third series, respectively.

A study of the results shows that a very large increase in yield was obtained from the use of the different forms and amounts of nitrogen. The best yields were obtained from the nitrate of soda in all the series, and, with the exception of series 1, the yield from the dried blood was superior to that from the sulphate of ammonia. The average increased yield in the three series from the use of nitrogen as nitrate was 1,762 pounds per plat, or 115 per cent; the average increased yield from the use of nitrogen as ammonia was 1,331 pounds per plat, or 87 per cent; and the average increase from dried blood was 1,398 pounds, or 91 per cent—that is, the gain of 115 per cent from the nitrate was 24 per cent greater than from the dried blood and 28 per cent greater than from the sulphate of ammonia. * * * While the application of nitrogen resulted in an increased yield in all the series, the best results were in all cases obtained from the smaller quantity used in series 1, * * * the relative returns per unit of application being 100, 86, and 79 for nitrate, ammonia, and organic nitrogen, respectively.

The amount of nitrogen applied in [series 1] apparently encouraged a normal development of the plant in all directions, resulting in a proportionately larger yield of fruit than when the larger quantity of nitrogen was applied, and which apparently resulted in the increased growth of vine at the expense of fruit. This decrease in the yield with the larger quantity was more noticeable in the case of the sulphate of ammonia than with either the nitrate of soda or the dried blood.

The largest values in all cases were obtained from the nitrate plats, and the smallest application in series 1 was the most profitable. "A very decided decrease in values followed from the application of the different forms of nitrogen in excess of the amount applied in series 1, and was greatest in all cases with the largest amount in series 3." The data further show that "nitrate of soda, when used in relatively small amounts, affects earliness in a more marked degree than the other forms."

With regard to culls, it is stated that "the percentages of culls on the nitrate plats were in all cases very much lower than from the plats treated with the other forms of nitrogen, and only in the case of the very large applications of this form did the percentage of culls reach that of the other forms, even when they were applied in what may be termed normal amounts."

Sweet corn.—The experiment with sweet corn was made with the same kinds and amounts of fertilizers as were used in the experiment with melons.

The addition of nitrogen in the different forms, as well as the different amounts applied, resulted in an increased yield in all cases. The average increased yield [of ears] from the use of nitrate of soda was 21.1, from sulphate of ammonia 25.4, and from dried blood 34.9 per cent.

The increased yield was, with but one exception, greatest with the heaviest application of nitrogen. It is thought that the better results given by the dried blood in this experiment may be due to the soluble nitrates having been carried in the early season beyond the reach of

the roots. Medium applications of fertilizers were most effective in increasing the yield of stalks, and sulphate of ammonia proved more efficient for this purpose than either of the other two forms tested.

This experiment, while less striking in its results than the others, is interesting in that it shows the relative influence of different forms of nitrogen for this crop, as well as the financial advantage resulting from the abundance of all forms of plant food.

The results of these experiments suggest the value of fertilizers on rich, well-tilled soils and the desirability of using the best forms of nitrogen on those crops "which, to be highly profitable, must make rapid growth in the early season, before soil agencies are active."—C. B. SMITH.

PECAN CULTURE.[1]

Botanically the pecan (*Hicoria pecan*) belongs to the hickory family. The tree is one of the largest of the forest, growing from 75 to 170 feet high, with wide spreading branches and symmetrical domelike top. The leaves are compound. They are composed of from 7 to 15 oblong lanceolate leaflets, green and bright above, with a rather rusty appearance beneath. The flowers are of two sorts on the same tree, staminate and pistillate. The nuts are generally oblong and vary in weight from 25 to over 100 per pound. The shells are relatively thin and much more easily cracked than those of the common hickory nut.

The pecan is found native in river bottoms from Iowa and Kentucky southwest into Mexico, and seems to prefer a moist rich soil. It is successfully grown, however, in many other States and on a variety of soils. The Michigan Station reports that pecan trees obtained from Iowa nuts have grown well at the South Haven substation since 1890, and proven entirely hardy. The Stuart pecan from Texas, however, has required protection to prevent its killing back each winter. Generally pecans will not be commercially successful north of parallel 40. Pecan nuts are grown on a commercial scale in California, and orchards have been planted in a number of Southern States. Texas and Louisiana at present furnish the main bulk of the annual crop, mostly from native trees. A bulletin recently issued by the Florida Station discusses in some detail the subject of pecan culture in that State, and will be largely made the basis of this article.

Florida is believed to be well adapted to the growth of pecans, especially in the western and northern parts, and there seems to be opportunity for a considerable extension of the industry. Trees grow in Florida on a number of soils, varying from the black hummock to the less fertile high pine lands. On the richer soil the trees seem

---

[1] For a very full discussion of the subject see bulletin on Nut Culture in the United States, issued in limited edition by the Division of Pomology of this Department in 1896.

inclined to develop wood at the expense of fruit, while on the poor soils the trees make less wood and bear more fruit proportionately. One writer from Georgia states that he has found sandy loam soils with a clay subsoil the best for pecans. The black lands come next, followed by pebbly lands. Trees on clay soils bore well and early, but the nuts were small. The trees on the sand ridges were of slow growth and were longer in coming into bearing, but produced good nuts.

FIG. 5.—The pecan.

Another writer in Florida states that sandy pine lands will produce them in perfection; still another that they will thrive on dry lands which are good for corn or cotton.

Pecans may be propagated from seed. They are liable to considerable variation, however, and budding and grafting are therefore resorted to in propagating desirable sorts. When trees are grown from seed

the seed bed should be prepared as for vegetables and the nuts planted on their sides, 3 inches apart, in rows 2½ feet apart, and covered 3 inches deep. They should be planted soon after they are ripe, and cultivation and fertilization given as with other trees. Planting nuts in the orchard where the trees are to stand is considered objectionable, since the ground is usually not as well prepared and many vacancies occur from the nuts being destroyed by rodents and ants.

The trees are difficult to bud or graft. Annular and veneer shield budding or cleft and whip grafting have proven the most desirable methods of budding and grafting. Various other species of Hicoria have been used for stocks, but the pecan is considered most satisfactory by many. A successful method of propagation recommended by a pecan grower is to plant common pecans and a big paper-shell variety close beside each other, and when two years old to use the paper shell as scion and the common pecan as stock. The scion should contain three buds. It is taken before growth starts in the spring and kept in moist sand. Later, when the stock has plenty of sap and is putting out leaves, the ground is cleared away from the crown and an oblique cut 2 inches in length made from the crown up. A similar cut is made on the scion. The graft is held in place by means of some kind of wrapping material, and then covered with a mixture of clay and gray moss, well mixed together and kneaded, or, what is still better, a grafting wax made by melting together 6 pounds rosin, 1 pound of beeswax, and 1 pint of linseed oil, applied warm, and the earth heaped over the stock.

The orchard where the trees are to be set should have been in some cultivated field or garden crop. Forty feet is believed to be sufficient distance apart for trees in Florida. If the triangular method of planting is adopted 40 trees can be grown on an acre. Planting between the latter part of November and the first of March is recommended. The trees may be set in the permanent orchard when two years old. If budded or grafted they should remain in the nursery one year longer. A small amount of complete commercial fertilizer thoroughly incorporated with the soil about the newly set tree is desirable. Clean cultivation may be given from March to July, followed by a cover crop of beggar weed, cowpeas, or velvet beans; or crops of cotton, velvet beans, melons, etc., may be grown between the rows, the area devoted to these crops being more and more restricted as the trees develop.

The pecan tree has a large tap root. When transplanted this should be cut off 15 or 18 inches from the crown, or back to solid wood, and all injured roots removed. Root pruning trees in the nursery row is recommended. The practice, it is thought, would favor the development of more lateral roots, and thus contribute to success in planting and early bearing. Pruning the tops of 1 and

2 year old trees at the time of setting is not considered advisable, as it tends to the development of shoots. Older trees when transplanted will require some top pruning. In general the training necessary for the pecan tree is confined largely to forming the head. This should be started 3 or 4 feet from the ground and the strong, upright, center limbs cut back to induce growth in the lateral branches and give the tree a rounded form.

By selection and cultivation a number of varieties of pecans have been originated which are great improvements over the native sorts. The points to be considered in estimating the value of pecans are quality and flavor, plumpness of kernel, ease with which the kernel separates, size, and the thickness of the shell. A thin-shell variety, other factors being equal, is most desirable. Stuart, Van Deman, Centennial, and Frotcher are considered standard sorts.

Pecan trees may bear a few nuts at an early age, but paying crops can not be expected under ten years, and full crops under twenty. The annual crop of a tree in full bearing has been variously reported as from 1 to 20 bushels.[1]—C. B. SMITH.

WEED DESTRUCTION BY MEANS OF CHEMICALS.

Much interest has been shown at a number of the agricultural experiment stations in the possibility of weed destruction by means of chemicals. As long ago as 1895 it was found at the Vermont Station that the orange hawkweed, a serious pest in pastures and meadows, could be destroyed without injury to the grass by sowing salt over the land at the rate of 3,000 pounds per acre. Many experiments have since been conducted at the same station with other chemicals for the eradication of weeds in walks, drives, courts, etc. Among the chemicals tested were salt, copper sulphate, kerosene, liver-of-sulphur, carbolic acid, arsenic and salsoda, arsenate of soda, and two commercial weed killers, the active principle of which apparently was arsenic. The weeds which it was sought to destroy were plantains, dandelion, chicory, ragweed, knotweed, and various grasses. All the chemicals were applied in solution except the salt. As in the case of the hawkweed experiments, salt was found efficient in destroying all the weeds when applied dry and in large quantity. When salt is used for this purpose adjacent lawns should be protected against washing, or they may be injured. Crude carbolic acid, 1 pint in 4 pints of water, applied at the rate of 8 gallons per square rod, was very efficient. The various arsenical preparations proved valuable as weed destroyers, and choice between them was largely a matter of expense. All things considered, the arsenate of soda and the carbolic acid solutions proved the most

[1] For discussion of the food value of the pecan as compared with other nuts, see U. S. Dept. Agr., Farmers' Bul. 122 (Experiment Station Work—XVI), p. 18.

valuable chemicals for weed destruction under the conditions of these experiments.

A most interesting series of experiments in weed destruction in fields of growing grain has been carried on at the North Dakota and other stations, as well as at many places abroad. Several years ago, in France, it was accidentally found that a solution of blue vitriol (copper sulphate) destroyed charlock or wild mustard plants. Acting upon this hint, experiments have been conducted in France, Germany, and England, where charlock is one of the worst weeds in grain fields, meadows, and pastures. The method employed is to spray the crop with solutions of blue vitriol while the weeds are young and not too well protected. While the results obtained are in some respects conflicting, the best results have been secured when a 2 per cent solution (1 pound to about 6 gallons of water) is sprayed over the field at the rate of from 40 to 60 gallons per acre. The spraying should be done on a clear, still day, and before the weeds begin to come into flower. If a rain should fall within twenty-four hours, or the weeds are too old, a second spraying will be necessary. This treatment has been repeatedly tested without permanent injury to wheat, oats, barley, and rye, while such weeds as charlock, shepherd's purse, penny cress, etc., were almost completely destroyed. No injury followed such treatment upon young clover growing in the grain. At the North Dakota Experiment Station a 10 per cent solution of blue vitriol was sprayed over an exceptionally weedy plat of wheat, the principal weeds being charlock, wild barley, wild rose, penny cress, shepherd's purse, wild buckwheat, lamb's quarter, and great ragweed. The spraying was made June 1 when the wheat was 3 to 5 inches high, and on August 8 all the weeds except the wild rose and the older plants of penny cress were dead. Some of the leaf tips of the wheat had been slightly burned, but the yield of grain was considerably larger than from an equal unsprayed area. On June 20 part of an oat field containing many weeds was sprayed with a solution of 1 pound of copper sulphate to 4 gallons of water. The oats at the time were about 6 inches high, the weeds being about the same height. An examination of the plats was made on August 1, and the treated area was free of all weeds except pigeon grass and wild rose. The oat plants were stalky and well stooled, while on the untreated area the plants were weak and failed to stool. The crop on the sprayed portion was believed to be at least one-third more than upon the unsprayed area. The solution was employed at the rate of 40 gallons per acre.

In some regions objections have been raised against the use of solutions of copper sulphate, especially upon plants intended for forage, since it might be possible for animals to get an amount sufficient to kill them. While such a condition of affairs is possible, yet it is hardly probable in the usual practice of weed destruction. To overcome this

difficulty the use of solutions of copperas (iron sulphate) is recommended. Where copperas is employed it will be found necessary to have a stronger solution than where blue vitriol is used. Copperas solutions should be from 10 to 15 per cent, or about 1 pound of the chemical to each gallon of water. The results secured with this chemical do not seem to be quite as satisfactory as where the copper sulphate is used, and the increased strength of solution required makes their cost about the same.

It must not be expected that all weeds may be destroyed by chemicals, at least in an economical way. Some weeds are so protected by hairs, scales, wax, etc., as to render their leaves impervious to the solutions as usually employed. Against such weeds the use of chemicals will be followed by disappointing results, but against charlock, wild mustard, shepherd's purse, wild radish, and penny cress, they may be successfully used if the application be made according to the suggestions given above. The solutions have been found to retard the growth of other weeds, without completely destroying them, as follows: Curled dock, bindweed, dandelion, sow thistle, and groundsel. In any case the results attained will depend upon the thoroughness of the application.—W. H. EVANS.

MAPLE SIRUP AND SUGAR.

Under the influence of sunlight the chlorophyll cells (those containing green coloring matter) in the leaves of plants form starch from water and the carbon dioxid of the air. The starch is transferred by the plant to the portions where it is needed for growth or where it is to be stored as a reserve material, being first converted into soluble carbohydrate, since the starch granules can not pass through the cell walls. When the carbohydrate material reaches the place where it is to be stored it is again converted into starch. When needed by the plant, the starch is reconverted into soluble carbohydrate and then transferred from one part of the plant to another, as the requirements of growth demand. The sugar maple and other maples form, store, and transfer their carbohydrate material in this way. During the winter the reserve starch probably remains unchanged, but in the spring it is converted into sugar, and when dissolved in a large proportion of water constitutes the sap we are all familiar with. Besides sugar the sap contains some mineral matters, such as salts of lime, potash, iron, magnesium, etc., and acids and other organic bodies.

The Vermont Station has made extended studies of maple sap, sirup, and sugar, and of the methods of sugar making. Similar work has been done by the New Hampshire Station. At a number of the stations maple sugar and sirups have been examined with the view to detecting adulteration in carrying out the provisions of the local pure-food laws. Some of this work is here summarized.

The Vermont Station calls attention to the well-known fact that the sugar in the maple sap is chemically identical with that from the sugar cane, and may be obtained equally pure and white if suitable methods of refining it are followed. However, it is not desirable to make refined sugar from maple sap, as maple sugar and sirup are prized for their peculiar and delicate flavor. This, as well as the brownish color, is owing to the substances besides sugar contained in the sap and to the caramelization of some of the sugar when the sap is boiled down. Maple-sugar making is an industry confined almost exclusively to the northern or mountainous regions. In the late winter or early spring the trees are tapped. The sap is purest—that is, contains the smallest amount of material other than sugar—when it first begins to run. As the season advances the sugar changes in accordance with the laws regulating the growth of the plant. These changes begin early in the spring and go on rapidly. According to the Vermont Station, by the time the buds have noticeably swelled one-fourth or more of the sugar has been converted into materials resembling glucose. All maple sirups examined were found to contain some material besides cane sugar. The amount in the best sirups was about 1 per cent, the proportion increasing as the season advanced until sirup made in the latter part of the season contained a large amount. Some glucose is also formed by the inversion of cane sugar during the process of sugar making.

When maple sirup and sugar are made, the sap is collected and boiled down or evaporated, the process varying somewhat in different regions and in the hands of different makers.

In the Vermont methods of making sugar, when the sirup is supposed to be done enough it is raised from the stove and stirred until the grains of sugar begin to show; usually stirred until it is quite thoroughly grained. During this process the temperature is all the time falling, but at the same time steam is passing off and the sirup is becoming concentrated, and therefore contains a higher percentage of sugar. * * * As the sap boils down little change takes place except the loss of water, provided the sirup is good and is properly handled, but a poor sirup, or a good sirup poorly treated, will lose sugar as well as water, through the burning or "inverting" of the sugar. * * *

If the sugar is to be caked or granulated, of course the stirring is longer and the consequent loss of water and increase of sugar is greater. * * * When sap begins to boil, its temperature is about 213°; as it boils down and becomes thicker, the temperature at which it boils rises until toward the end it may be 235°-240°, or even as high as 245°. * * *

At a temperature of 230°-234° F., a moist, mushy "tub sugar" will be made which will drain a good deal of molasses, while at 240° and upward a very hard crystalline "cake sugar" will be obtained. The former will seldom contain 80 and the latter will sometimes contain 90 per cent of sugar.

The particular point in making sirup is to get it as thick as possible without having it granulate on standing. The ordinary rule of the maker is to make sirup that shall weigh 11 pounds to the gallon, and we have found by experiment that this custom is exactly right, and that the temperature corresponding to this weight is 219°. That

is, if the sirup is taken off from the fire as soon as it shows a temperature of 219° it will weigh exactly 11 pounds to the gallon and will not grain on standing. This is, however, the extreme limit; if the temperature is allowed to get a single degree higher the sirup will granulate. In practice not much of the sirup that is on the market is quite up to this point, most of it being taken off just before it reaches 219°, and large quantities were on the market * * * which boiled at 216°, or even less. * * *

[In addition to sugar] the sirup also contains mineral matter, malate of lime ("niter" or "sugar sand"), burned sugar, and toward the end of the season various materials resembling glucose, due to the starting of the buds and the beginning of the summer's growth of the tree. These extra materials at the beginning of the season are about one-sixth the weight of the sugar, and increase until in some very poor and black "last run" they may amount to 30 pounds for every hundred pounds of actual sugar present. Hence 100 pounds of a first-class sirup boiling at 228°, instead of containing 80 pounds of sugar, contains about 75 pounds of sugar and enough of the other materials, 5 pounds, to make up 80 pounds, the other 20 pounds being water. * * * The more the impurities the higher the temperature to which the sirup will have to be heated.

From the average of a number of American analyses, it appears that commercial maple sugar contains 83 per cent of pure sugar, the remainder being made up of water, coloring matter, some salts, etc. At the Vermont Station some of the samples analyzed contained over 95 per cent of pure sugar. According to the average of a large number of American analyses, maple sirup contains, in addition to water, 71 per cent sugar. The thin sirups often found on the market undoubtedly contain less. Maple sugar and sirup serve the same purpose in the dietary as other non-nitrogenous nutrients—that is, they furnish the body with energy and, like other carbohydrates, may doubtless be converted into some reserve material and stored in the body. In earlier times maple sugar and sirup were used in parts of this country as staple articles of diet in place of the expensive products made from the sugar cane. At the present date they are relatively higher in price than sugar-cane products and are prized for their peculiar flavor, and are luxuries rather than staple articles of diet. These materials are very frequently adulterated, and doubtless much that is sold under the name of maple sirup or sugar does not contain any of the product of the maple tree. Such adulteration and misbranding should be prevented by suitable legislation.

Recently the Indiana Station analyzed a sample of what is known as "niter" or "sugar sand," an impurity derived from the sap, which is said to be found in all sirups, though in variable quantities. In sugar making the sirup is often allowed to stand until the niter settles out, when it may be strained. This sugar sand was found to have the following percentage composition: Water, 6.11; insoluble matter, 9.13; reducing sugars, 12.74; sucrose (cane sugar), 26.88; calcium, 12.89; malic acid, 20.86; potash, 0.72: protein, 0.40, and magnesium, a trace. The material is principally malate of lime, and it is suggested that it might be of some value as a source of malic acid.

The Division of Chemistry of this Department has reported a number of investigations on maple sugar and sirup and on the adulteration of these goods.[1]—C. F. LANGWORTHY.

VALUE OF COTTON SEED TO THE FARMER.

The results of two years' feeding experiments with milch cows to determine the value of cotton seed to the farmer are reported in a bulletin of the Mississippi Station, of which the following is a summary:

The facts as demonstrated are: (1) A pound of cotton seed has a greater value for feeding cattle than a pound of corn; (2) a pound of cotton-seed meal has a feeding value about equal to 2 pounds of corn; (3) that at least 85 per cent of the fertilizing ingredients in the feeds is excreted by the animals fed, and may be recovered in the manure; (4) that nearly half of the fertilizing ingredients excreted is found in the urine; (5) that both cotton seed and cotton-seed meal may constitute a very important part of the grain feed of cattle without injury to their health; (6) that cotton seed and cotton-seed meal, when fed to dairy cows in proper quantity and properly combined with other feeds, do not injure the quality of either milk or butter.

With corn at 40 cents per bushel (about the average price in this State) a ton of cotton seed is worth $16.70 as a feed, for either beef cattle or dairy cattle. At present prices for commercial fertilizers nitrogen costs about 12 cents per pound and phosphoric acid and potash each 5 cents per pound. Allowing these prices for the same ingredients in manure, we have $9.09 as the fertilizing value of the manure for each ton of seed fed, making for a farmer a total value per ton of $25.79. Farmers sell their seed for $4 to $6 per ton. Some of them sell for $2 per ton.

In a similar way we find the feeding value of a ton of cotton-seed meal to be $28.56, and the manure to be worth $19.13 for every ton of meal consumed, making a total value of $47.69 that a farmer might derive per ton by first feeding the meal to cattle and applying the manure to his land. * * *

The cotton crop for the South [in 1897–98] was 11,200,000 bales and 5,600,000 tons of seed, having a combined feeding and fertilizing value of $144,424,000. At $5 per ton the seed would have brought $28,000,000. * * * The farmers of the cotton belt lost $116,424,000 [on this one crop].

The present disposition of the cotton-seed crop secures to the farmer a very small part of its real value, and must of necessity give place to a practice that will secure to the farmer the maximum benefit which he may derive from this product.

The time will come when the Southern farmer will realize that the fertilizing value in cotton seed must stay on the farm to maintain its fertility and productiveness.

He will not always regard the matter of hauling as of no consequence—as something which he can do without cost. If the best disposition of cotton seed is finally demonstrated to be to extract the oil for human food and other commercial purposes, and let the meal and hulls go back to the farms to serve both as feed and fertilizer, then most likely there will be a small oil mill at each ginnery and oil and lint will be the only products of the cotton crop sent to the market.

The Southern farmer, however, need not wait for oil mills. He may get the full value of his cotton seed by a judicious system of feeding, accompanied by the most careful saving and proper use of the manure.

—THE EDITOR.

---

[1] U. S. Dept. Agr., Division of Chemistry Bul. 5, Pt. I, and Bul. 13, Pt. VI.

ALFALFA SILAGE.

A bulletin of the Colorado Station thus summarizes the results of tests of alfalfa as a silage crop:

Some tests were carefully made on a small scale to see what losses might be expected in making silage of alfalfa. One test was made with the alfalfa put in whole as cut in the field, the other with the alfalfa cut to quarter-inch pieces as we cut our corn for silage. The whole alfalfa showed a spoiled layer 3 inches thick on the top and an inch layer around the side nearly all the way down. The silage of the bottom and middle was excellent and was greedily eaten by the cows and calves. Its loss in the total weight was 10.7 per cent, but its loss in feeding value was probably a little larger.

The other silo was filled with cut alfalfa. The next day the silo was covered with two thicknesses of building paper and one of boards and weighted with stone to about 55 pounds per square foot. When covered, the silage was hotter than the hand could bear. Two days later the temperature had fallen to 83° F. and in two days more it had fallen to that of the air. The silage shrank and settled a good deal. When put in it contained 33 per cent of dry matter. On opening, the silo showed 2 inches of spoiled silage on top and half an inch on the sides. The spoiled silage was 7.3 per cent of the total weight. The loss in dry matter was approximately 10 per cent.

It is fair to presume that with a good tight silo, well made silage from cut alfalfa should not make a larger loss than was here given in our small experimental silo, or about 10 per cent of its feeding value. To make good silage from whole alfalfa is a much harder proposition. It requires that the alfalfa be quite green; that the silo be both tight and deep; that the alfalfa be thrown into the silo in small forkfuls and carefully tramped, and that it be weighted by 4 to 6 feet of some heavy, tight packing material like cut-corn fodder. If the alfalfa is put up in the middle of summer in clear, bright weather, it must be raked and loaded as fast as cut. One lot we tried was too dry for silage two hours after it was cut.

—THE EDITOR.

FORAGE CROPS FOR PIGS.

In many regions of the South and West successful pig raising depends in large measure upon satisfactory forage crops. When a crop can be grown cheaply, gives a fair yield, produces satisfactory gains in weight and flesh of good flavor, its great value is evident. Some of the forage crops commonly grown for this purpose have the additional advantage that pigs can be turned on them, and thus the cost of harvesting and handling avoided. The value of different forage crops for pigs has been studied by several of the stations. Some recent work of this sort was done at the South Carolina and Oklahoma stations. Earlier work by the Kansas Station was noted in a previous bulletin of this series.[1]

At the South Carolina Station four lots of pigs were used in the test. One was fed Spanish peanuts, one sweet potatoes, and one cowpeas, while the remaining lot, which served as a standard for comparison, was fed corn. On land of the same character as that which yielded

---

[1] U. S. Dept. Agr., Farmers' Bul. 56 (Experiment Station Work—I), p. 6.

15 bushels of corn per acre the yield of Spanish peanuts was 90 bushels, cowpeas 10, and sweet potatoes 200. With the exception of the cowpeas, the cost of producing the crops would be practically the same, provided they were harvested by the pigs.

The amount of the different feeding stuffs required to produce a pound of pork was: Corn, 6.02 pounds; Spanish peanuts, 4.43 pounds; sweet potatoes, 32.47 pounds, and cowpeas, 4.91 pounds. Taking account of the gains made and the yield of different crops, and rating pork at 5 cents per pound, the corn was calculated to be worth $6.97 per acre, Spanish peanuts $24.37, sweet potatoes $18.47, and cowpeas $6.12.

The pigs used in this test, which covered thirty-three days, weighed from 117 to 200 pounds when the trial began. They were regarded as too large for the best results.

The hams from the pigs fed the different crops were all cured in the same way. The shrinkage did not vary greatly, ranging from 22 to 27 per cent. The lean meat in the hams from the pigs fed Spanish peanuts exclusively was coarse and stringy. The hams were tainted somewhat, though treated like the others in every particular. The lard from these pigs had a lower melting point than that from those fed the other crops.

The South Carolina Station advises pasturing pigs on a small area at a time, using a movable fence of light wire. The following suggestions regarding forage for pigs are the result of the station's experience:

Rye for winter and spring pasturage; rye and wheat for June pasturage; ripe peanuts, chufas, and artichokes for fall, winter, and early spring; in conjunction with green rye, early black-eyed, whippoorwill, or bunch black peas to follow the wheat harvest, sweet potatoes, and early varieties of corn in July and August, together with early crop of Spanish peanuts and field peas and early amber sorghum, followed by patches of larger varieties of sorghum and the regular fall crops of corn, potatoes, field peas and peanuts, leaving the chufas and artichokes to be used during the winter and early spring. There should be a permanent pasture of Bermuda grass, together with vetch or some perennial grass adapted to the soil and climate, to be used as a run when the ground is too wet to be rooted by the hogs in the special crops. Bermuda grass furnishes pasturage for hogs equal to and more permanent than clover.

At the Oklahoma Station alfalfa pasture, with and without the addition of grain, was studied with a number of pigs. Other forage crops were also tested, including sugar beets, cowpeas, sorghum, sweet potatoes, and peanuts. During part of the test the feeding stuffs were cut and fed; during the remainder of the time they were harvested by the pigs.

These tests led to the following general conclusions:

Alfalfa is excellent as pasture for hogs. Pigs will make some gain with no other food; excellent gains when fed grain while on the alfalfa. Continuous pasturing will injure and may destroy the alfalfa. With rare exceptions, alfalfa should not be pas-

tured the year it is sown. Sorghum also makes a fair pasture for hogs. Sowing cowpeas, planting peanuts or sweet potatoes, and allowing hogs to harvest the crop, giving them some grain in addition, reduces the cost of pork production. Sugar beets are much relished by any class of stock. The greater cost of growing them as compared with other crops makes it doubtful if they are an economical crop when used in large quantities.

—C. F. LANGWORTHY.

GRAZING STEERS ON CORN AND COWPEAS.

It is evident that allowing cattle to gather a crop instead of harvesting and feeding it must be a saving of expense. If at the same time the gains made are satisfactory, this method of feeding should commend itself.

The Arkansas Station recently tested the desirability of grazing steers on a field of corn and cowpeas, supplementing this food with as much cotton seed as the animals required. The 5 steers used in the test were turned on a 5-acre field after the corn had been pulled. The yield of corn was 25 bushels to the acre, which is regarded as hardly an average crop. The cowpeas gave more than an average growth of vines, but less than an average crop of peas. None of these had been picked.

The steers required sixty-five days to consume all the food on the 5 acres. They were allowed access to only one-third of the field at a time. The cotton seed was always accessible and was consumed at will. During the first thirty days of the test, while the pea vines were yet green and peas were accessible, the steers ate very little cotton seed.

At the beginning of the test the 5 steers weighed 3,858 pounds. The average daily gain was 2 pounds per steer. The average amount of cotton seed consumed per steer during the whole test was 250 pounds. Rating cotton seed at $6 per ton, and making suitable allowance for the cowpeas planted, the cultivation of the crop, and the labor of feeding the steers, the cost of a pound of gain was calculated to be 1.6 cents.

In estimating the cost of the grazing, the cotton seed and cowpeas are charged to the feeding, but it is reasonable to suppose they will, as manure scattered over the soil, increase the yield of the succeeding crop more than their cost. The advantages of feeding cotton seed to the steers instead of corn are cheapness as a food and greater value as a fertilizer. It was estimated that the steers grazed the three lots of the field about as follows: On the first plat, one-third of the field, all the pea vines, husks, fodder, and about one-fourth of the stalks were eaten; on the second and third plats, each one-third of the field, frost having fallen October 22, the steers ate about two-thirds of the pea vines, all the husks and fodder, but scarcely any of the stalks. The results of the grazing of this field indicate that the corn should be gathered and the animals turned to grazing as early as possible before frost.

Judging by the results obtained at the Arkansas Station, this method of feeding is profitable and worthy of further trial.

—C. F. LANGWORTHY.

THE TYPE OF DAIRY COW IN RELATION TO MILK AND BUTTER PRODUCTION.

The importance of conformation in the selection of dairy cows has been a subject of much discussion. Recent bulletins of the experiment stations have furnished considerable data bearing on this question. Summaries of two of the more recent of these bulletins are here presented as indicating the views and evidence of those who attach first importance to external conformation in judging of dairy cows.

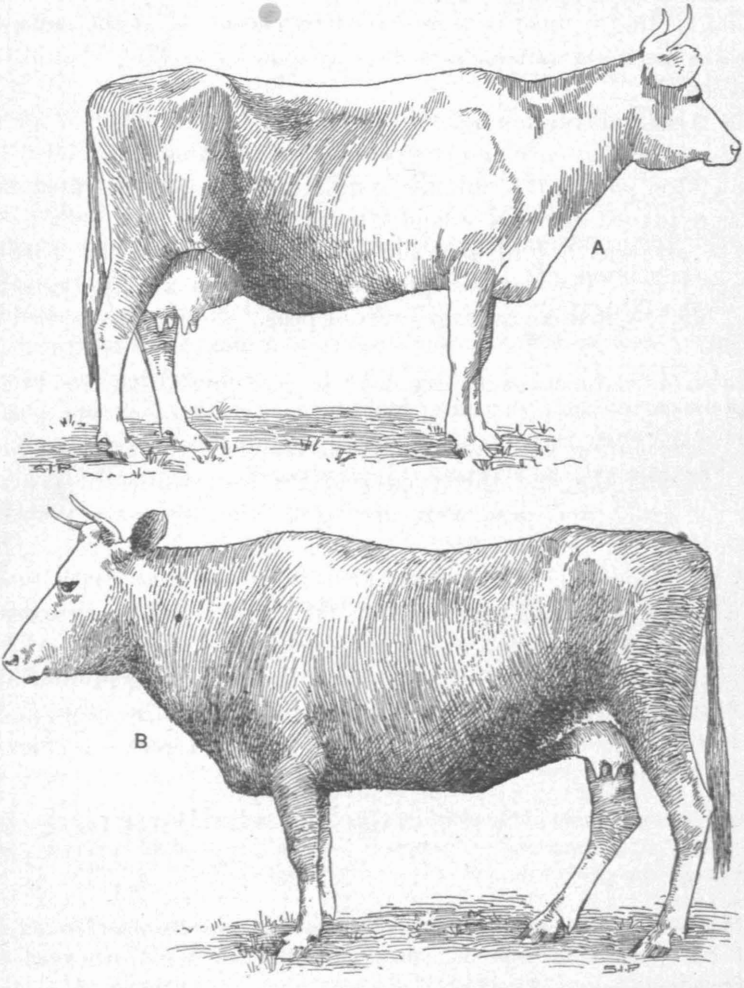

FIG. 6.—Dairy and beef types of the same breed—Jersey: A, Dairy type—spare and deep body, well sprung ribs, large udder development. B, Beef type—large frame, small udder development, taking on flesh easily, smooth and plump.

The Minnesota Station has published a record for two years of cows divided into two groups according to type. Group 1 contained cows spare and angular in conformation and having deep bodies through the middle; and group 2, cows having a tendency to lay on flesh.

During the two years group 1 included 2 Guernseys, 2 Jerseys, 1 Jersey-Guernsey, and 1 grade Holstein; and group 2, 5 grade Shorthorns, 1 Swiss, and 1 grade Holstein. All the cows were treated alike in every respect. The principal data for the two years are summarized in the following table:

Average records of cows of different types at the Minnesota Station.

	Number of cows.	Cost of food.	Milk produced.	Cost of 100 pounds milk.	Butter produced.	Cost of 1 pound butter.
1895:		*Dollars.*	*Pounds.*	*Cents.*	*Pounds.*	*Cents.*
Group 1, spare and angular, with deep bodies through the middle...	4	30.82	8,283.1	37.20	445.97	6.91
Group 2, having a tendency to lay on flesh	4	28.21	6,817.6	41.38	303.01	9.31
1896:						
Group 1, spare and angular, with deep bodies through the middle...	5	23.35	8,580.3	27.21	460.02	5.08
Group 2, having a tendency to lay on flesh	5	22.11	6,248.9	37.80	270.86	8.02

In 1895 the 4 cows in group 1 returned in dairy products at market prices an average profit of $46.95 per cow over the cost of food, while the 4 cows in group 2 gave a corresponding net return of only $26.19 per cow. In 1896 the average net return per cow was $56.91 for group 1 and $26.72 for group 2. Records of a larger number of cows grouped as above for the period from the beginning of lactation in the fall until the cows were turned out to pasture in the spring, and also for full lactation periods, showed a corresponding degree of superiority as regards economy of production of cows spare and angular in form over those with flesh-producing tendencies.

These and earlier records of the station herd were thought to show that economy in butter production depends more upon the type of cow than upon breed or size. The records also indicate that cows of the spare and angular type remain in good service for a much longer period than cows having a tendency to lay on flesh.

During the five years of careful investigation in regard to the cost of production of butter between cows spare and angular in form and cows carrying considerable superfluous tissue, and having an inherited or acquired disposition to convert feed into flesh, the records show that in every instance the cow that carried the least flesh charged the least for butter, and just in so much as one cow was a little smoother and plumper than the other would her butter product cost more than the other.

In a study of dairy cows at the Connecticut Storrs Station the factor of breed was largely eliminated by comparing in most cases the records of cows of the same breed. The whole dairy herd, composed of Jerseys, Guernseys, Ayrshires, and grades of different breeds, was divided into three groups solely on the basis of form and type. Group 1, designated as the dairy group, included cows with spare and deep bodies and well-sprung ribs. Group 2, styled the beef group, included large-framed cows taking on flesh easily and looking smooth and plump (fig. 6). Group 3 contained cows lacking

in depth and width of body. The records for one year are averaged in the following table by types and breeds:

Average records of cows of different types and breeds at the Connecticut Storrs Station.

	Number of cows.	Cost of food.	Milk produced.	Cost of 100 pounds milk.	Butter produced.	Cost of 1 pound butter.
Types:		*Dollars.*	*Pounds.*	*Cents.*	*Pounds.*	*Cents.*
Dairy	16	41.66	6,190	69	351	12.0
Beef	4	38.59	3,916	100	217	18.1
Lacking depth	5	39.83	5,322	77	267	14.9
Breed:						
Jersey	4	43.35	5,981	75	371	12.1
Grades	14	39.99	5,523	76	314	13.2
Guernseys	3	41.40	5,140	83	293	14.3
Ayrshires	4	40.65	6,166	69	266	16.0
Average of herd	25	40.80	5,653	76	313	13.6

The dairy type, compared with the beef type, produced on the average per cow 134 pounds more butter and 2,274 pounds more milk; yielded $20.94 more profit in butter and $19.68 more in milk; produced milk at 31 cents less per hundred and butter at 6.1 cents less per pound.

In comparing the dairy type with the type lacking depth and width of body, we find the former produced on the average per cow 84 pounds more butter and 868 pounds more milk; yielded $13.13 more profit in butter and $6.84 more in milk; produced milk at 8 cents less per hundred and butter at 2.9 cents less per pound.

The dairy type, compared with the Ayrshires, produced on an average per cow 85 pounds more butter and 24 pounds more milk; yielded $14.17 more profit from butter and 77 cents less from milk; produced milk at the same cost per hundred and butter at 4 cents less per pound.

The dairy type, compared with the Guernseys, produced on the average per cow 58 pounds more butter and 1,050 pounds more milk; yielded $10.04 more profit from butter and $10.24 more profit from milk; produced milk at 14 cents less per hundred and butter at 2.3 cents less per pound.

The dairy type, compared with the grades, produced on the average per cow 37 pounds more butter and 667 pounds more milk; yielded $5.03 more profit from butter and $5.04 more from milk; produced milk at 7 cents less per hundred and butter at 1.2 cents less per pound.

The dairy type, compared with Jerseys, produced 20 pounds less butter and 209 pounds more milk; yielded $1.98 less profit from butter and $3.78 more from milk; produced milk at 6 cents less per hundred and butter at 0.1 cent less per pound.

The record shows that in our herd the dairy type is nearly equal to the Jersey, and excels the other breeds, in production of butter. The dairy type is equal to the Ayrshires, and excels the other breeds, in the production of milk. On the whole the comparison seems to show that, under the present conditions, the type of the cow is more essential than the breed as indicating the ability to produce milk and butter economically.

—H. W. LAWSON.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FERTILIZERS.

Complete fertilizer is one which contains the three essential fertilizing constituents, i. e., *nitrogen, phosphoric acid,* and *potash.*

Nitrogen exists in fertilizers in three distinct forms, viz, as *organic matter,* as ammonia, and as nitrates. It is the most expensive fertilizing ingredient.

Organic nitrogen is nitrogen in combination with other elements either as vegetable or animal matter. The more valuable sources are dried blood, dried meat, tankage, dried fish, and cotton-seed meal.

Ammonia is a compound of nitrogen more readily available to plants than organic nitrogen. The most common form is sulphate of ammonia, or ammonium sulphate. It is one of the first products that results from the decay of vegetable or animal substances.

Nitrates furnish the most readily available forms of nitrogen. The most common are nitrate of soda and nitrate of potash (saltpeter).

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Superphosphate.—In natural or untreated phosphates the phosphoric acid is insoluble in water and not readily available to plants. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available to plants. Superphosphates are sometimes called acid phosphates.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All *forms* are freely soluble in water and are believed to be nearly, if not quite, equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvinit, muriate of potash, sulphate of soda, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Albuminoids is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are often classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, beside real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned, to furnish heat and energy.

MISCELLANEOUS TERMS.

Leguminous plant is a plant of the botanical order Leguminosæ, the more common representatives of which are clover, peas, beans, etc.

Micro-organism, or **microscopic organism,** is a plant or animal too small to be seen without the aid of a compound microscope.

Bacterium (plural, **Bacteria**) is the name applied in common to a number of different or closely related microscopic organisms, all of which consist of single short cylindrical or elliptical cells, or two such cells joined end to end and capable of spontaneous movement. Many kinds of bacteria are harmful, and cause diseases and other injurious effects, but many are beneficial. Among the latter are those which give flavor to butter and cheese, and those which enable leguminous plants to use the free nitrogen of the air.

Inoculation is the introduction of bacteria or other organisms into surroundings suited to their growth, with a view to producing certain effects which are the result of their activity.

Humus is the name applied to the partially decomposed organic (animal and vegetable) matter of the soil. It is the principal source of nitrogen in the soil.

Stamen.—Part of a flower which produces pollen.

Staminate, producing stamens.

Pistil is the ovule-bearing organ of the flower. It is often called the fertile or female organ.

Ovules are bodies which, when acted upon by pollen, become seeds.

Pistillate, producing pistils.

Chlorophyll.—The green coloring matter of plants. By the combined action of chlorophyll and sunlight plants are able to build tissue from the carbon dioxid and water of the atmosphere.

Lactation.—The formation or secretion of milk. The "period of lactation" as applied to cows means the length of time after calving that they give milk.

O